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Notice of Allowability	Application No.	Applicant(s)	
	10/642,935	IKEZAKI, YOSHIKAZU	
	Examiner	Art Unit	
	Tiffany A Fetzner	2859	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 08/18/2003.
2. ☒ The allowed claim(s) is/are 1-17.
3. ☐ The drawings filed on _____ are accepted by the Examiner.
4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 - a) ☒ All b) ☐ Some* c) ☐ None of the:
 1. ☒ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
 6. ☒ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
 - (a) ☒ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
 - 1) ☒ hereto or 2) ☒ to Paper No./Mail Date 08/18/2004.
 - (b) ☒ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date 08/18/2004.
- Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).**
7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

- | | |
|--|--|
| 1. <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 5. <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 2. <input checked="" type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 6. <input checked="" type="checkbox"/> Interview Summary (PTO-413),
Paper No./Mail Date <u>08/18/2004</u> . |
| 3. <input checked="" type="checkbox"/> Information Disclosure Statements (PTO-1449 or PTO/SB/08),
Paper No./Mail Date <u>08/18/2003</u> | 7. <input checked="" type="checkbox"/> Examiner's Amendment/Comment |
| 4. <input type="checkbox"/> Examiner's Comment Regarding Requirement for Deposit
of Biological Material | 8. <input checked="" type="checkbox"/> Examiner's Statement of Reasons for Allowance |
| | 9. <input type="checkbox"/> Other _____ |

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Examiner's Amendment

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it **MUST** be submitted no later than the payment of the issue fee.
2. Authorization for this examiner's amendment was given in a telephone interview with Associate **Nish Patel** who has a **Certificate of Limited Recognition** to act on application before the USPTO for **Attorney Patrick Rasche Reg. No. 37,916** on August 17, 2004 along with authorization to charge any necessary fees to applicant's deposit account.
3. The application has been amended as follows:

A) Replace claim 1 with the following Examiner amended claim 1:

Claim 1 --- A magnetic resonance imaging apparatus comprising:
an exciting and acquisition device configured to excite spins within a subject;
a plurality of parallel receiver systems configured to acquire, by applying a reduced field-of-view, imaging echoes generated by the excited spins along with navigator echoes;
a first correcting device configured to conduct phase correction on said imaging echoes based on at least one of said navigator echoes;
a first image producing device configured to produce an intermediate image based on said phase-corrected imaging echoes from said plurality of parallel receiver systems;
a separate generating device configured to generate a sensitivity matrix corresponding to and from said plurality of parallel receiver systems;
a second correcting device configured to phase-correct matrix data in said sensitivity matrix; and
a second image producing device configured to produce an output image with a full field-of-view based on said intermediate image and said phase corrected sensitivity matrix. ---

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B) Replace claim 2 with the following Examiner amended claim 2:

Claim 2 --- The magnetic resonance imaging apparatus of **claim 1**, wherein a reduction factor corresponding to said reduced field-of-view satisfies $n \geq R > 1$ wherein **R** is the reduction factor, and **n** is a number of said parallel receiver systems. ---

C) Replace claim 3 with the following Examiner amended claim 3:

Claim 3 --- The magnetic resonance imaging apparatus of **claim 1**, wherein said exciting and acquisition device implements said reduced field-of-view by enlargement of sampling intervals represented in a k-space. ---

D) Replace claim 4 with the following Examiner amended claim 4:

Claim 4 --- The magnetic resonance imaging apparatus of **claim 3**, wherein said exciting and acquisition device implements said enlargement of the sampling intervals by enlargement of a step difference of phase encoding. ---

E) Replace claim 5 with the following Examiner amended claim 5:

Claim 5 --- The magnetic resonance imaging apparatus of **claim 1**, wherein said plurality of parallel receiver systems have respective receiving coils ---

F) Replace claim 7 with the following Examiner amended claim 7:

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Claim 7 --- The magnetic resonance imaging apparatus of **claim 1**, wherein said exciting and acquisition device employs a multi-shot diffusion-weighted echo planar imaging technique in acquiring said imaging echoes. ---

G) Replace claim 8 with the following Examiner amended claim 8:

Claim 8 --- The magnetic resonance imaging apparatus of **claim 1**, wherein said acquiring device employs a technique other than a multi-shot diffusion-weighted echo planar imaging technique in acquiring said imaging echoes. ---

H) Replace claim 9 with the following Examiner amended claim 9:

Claim 9 --- The magnetic resonance imaging apparatus of **claim 1**, wherein said generating device generates said sensitivity matrix based on a spatial distribution of reception sensitivity of said plurality of parallel receiver systems with respect to the full field-of-view. ---

I) Replace claim 10 with the following Examiner amended claim 10:

Claim 10 --- The magnetic resonance imaging apparatus of **claim 9**, wherein said generating device generates said sensitivity matrix after fitting the spatial distribution of a magnitude of the reception sensitivity of each of said plurality of parallel receiver systems to a two-dimensional polynomial. ---

J) Replace claim 11 with the following Examiner amended claim 11:

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Claim 11 --- The magnetic resonance imaging apparatus of **claim 10**, wherein said generating device conducts said fitting by applying a method of least squares including applying a weight that depends upon the magnitude of the reception sensitivity. ---

K) Replace claim 12 with the following Examiner amended claim 12:

Claim 12 --- The magnetic resonance imaging apparatus of **claim 11**, wherein the weight is a square of the magnitude of the reception sensitivity. ---

L) Replace claim 14 with the following Examiner amended claim 14:

Claim 14 --- The magnetic resonance imaging apparatus of **claim 1**, wherein said second correcting device homogenizes a phase. ---

M) Replace claim 15 with the following Examiner amended claim 15:

Claim 15 --- The magnetic resonance imaging apparatus of **claim 1**, wherein said second correcting device sets a phase to zero. ---

N) Replace claim 16 with the following Examiner amended claim 16:

Claim 16 --- The magnetic resonance imaging apparatus of **claim 1**, wherein said second correcting device sets a phase to a constant value other than zero.

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O) Replace claim 17 with the following **Examiner amended claim 17**:

Claim 17 --- The magnetic resonance imaging apparatus of **claim 1**, wherein said second image producing device employs an equation $V=(S^*S)^{-1} S^* A$ in producing said output image, wherein **V** represents pixel values of the output image with the full field-of-view, **S** represents the sensitivity matrix, **S*** represents an adjoint matrix of **S**, and **A** represents pixel values of the intermediate image.---

In the **title**:

P) Replace the title with: --- MRI Systems with Parallel Receivers for Phase Correction. ---

In the **original specification**:

Q) Replace the specification paragraph beginning on **page 10 line 24** and ending on **page 10, line 30** with the following **Replacement paragraph**:

The magnet system 100' has a main magnet section 102', a gradient section 106', and an RF coil section 108'. The main magnetic field magnet section 102' and the coil sections each **include** a pair of members facing each other across a space. The sections have a generally disk-like shape and are disposed to have a common center axis. A subject 1 is rested on a cradle 500 and carried into and out of an internal space (bore) of the magnet system 100' by a carrier means, which is not shown.

R) Replace the specification paragraph beginning on **page 14 line 1** and ending on **page 14, line 3** with the following **Replacement paragraph**:

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The imaging echoes in each repetition are phase-corrected by a navigator echo in the same repetition. This removes any phase error due to pulsation of the brain from the imaging echoes.

S) Replace the specification paragraph beginning on page 18 line 14 and ending on page 18, line 18 with the following Replacement paragraph:

Figure 10 shows a functional block diagram of the present apparatus for the above-described operation. As shown, the apparatus comprises a navigator and imaging echo acquiring section 802, a phase correcting section 804, an intermediate image producing section 806, a sensitivity matrix generating section 808, a phase correcting section 810 and an output image producing section 812.

T) Replace the specification paragraph beginning on page 18 line 19 and ending on page 18, line 24 with the following Replacement paragraph:

The navigator and imaging echo acquiring section 802 acquires navigator echoes and imaging echoes. The echoes are acquired according to the MS-DW-EPI technique with a reduced FOV, The navigator and imaging echo acquiring section 802 corresponds to the function of the present apparatus described at Step 707 shown in Figure 8. The navigator and imaging echo acquiring section 802 is an embodiment of the acquiring means of the present invention.

Examiner's Comment

Priority

4. Receipt is acknowledged of papers submitted under 35 U.S.C. 119(a)-(d), which papers have been placed of record in the file.

Information Disclosure Statement

5. The information disclosure statement (IDS) submitted on 08/18/2003 is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement has been considered by the examiner.

Drawings

6. The following changes to the drawings have been approved by the examiner and agreed upon by applicant:

- A) **Figure 8** shall be amended to **replace** component **705'** with component **705**.
- B) **Figure 8** shall be amended to identify box **707** as "**Scan to obtain navigator and imaging echoes**".
- C) **Figure 9** shall be amended to identify box **707** as "**Scan to obtain navigator and imaging echoes**".
- D) **Figure 10** shall be amended to identify box **802** as "**Navigator and Imaging echo acquiring section**". In order to avoid abandonment of the application, applicant must make these above agreed upon drawing changes.

The following is an examiner's statement of **Reasons for Allowance**:

7. With respect to **examiner amended claims 1-3, 5, 7-12, 14-17 and dependent claims 4, 6, and 13**; these claims are allowable over the prior art of record because the prior art of record does not disclose or suggest **an MRI apparatus with a structure comprising** an exciting and acquisition device configured to excite spins within a subject; a plurality of parallel receiver systems configured to acquire, by applying a reduced field-of-view, imaging echoes generated by the excited spins along with navigator echoes; a first correcting device configured to conduct phase correction on said imaging echoes based on at least one of said navigator echoes;" **and** "a first image producing device configured to produce an intermediate image based on said phase-corrected imaging echoes from said plurality of parallel receiver systems;" **occurring**

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separately from the components comprising “a separate generating device configured to generate a sensitivity matrix corresponding to and from said plurality of parallel receiver systems; a second correcting device configured to phase-correct matrix data in said sensitivity matrix;” **and then combining the structural components as required with the** “second image producing device configured to produce an output image with a full field-of-view based on said intermediate image and said phase corrected sensitivity matrix”.

8. **It is the combination of the structural examiner amended claim limitations taken as a whole that constitutes both the novelty and non-obviousness of applicant’s claims.** The structural order of the combinational components is the novel aspect of applicant’s invention, because in applicant’s invention, which contrasts with the prior art of record, the phase correction of the navigator and imaging echoes does not impact the sensitivity matrix, or the sensitivity corrections.

9. The prior art of record fails to require that the sensitivity matrix, not contain navigator phase-corrected echo data. The prior art requires that the forming of sensitivity data occur after navigator echoes are acquired, in order to take into account the navigator echoes, with respect to the imaging echoes. The prior art fails to consider applicant’s structural combination because it has been presumed by the prior art of record that sensitivity data for individual coils, which include a navigator echo, must account for the effect of the navigator echo on the respective sensitivities of the individual coils. The ability to accurately apply parallel coil sensitivities, to imaging echoes that use navigator phase correction of the imaging echoes without the parallel coil sensitivities being impacted by the navigator echo phase correction, has not been known, suggested, or taught prior to applicant’s instant invention. The examiner considers applicant’s **examiner amended claims** to be allowable over the **prior art of record** because the applicant’s structure teaches away from what is known in the prior art of record.

Prior Art made of Record

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10. The **prior art made of record** and not relied upon is considered pertinent to applicant's disclosure.

A) Jakob et al., US patent 6,289,232 B1 issued September 11th 2001, filed March 30th 1998.

B) Sodickson US patent 5,910,728 issued June 8th 1999, filed November 12th 1996.

C) Ikezaki US patent Application Publication 2004/0039276 A1 published February 26th 2004, which is the corresponding publication of applicant's instant application as originally filed. This reference is not available as prior art it is noted only for the purposes of a complete record.

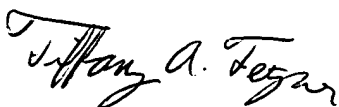
D) All of the Prior art cited on the information disclosure statement of August 18th 2003.

11. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tiffany Fetzner whose telephone number is: (571) 272-2241. The examiner can normally be reached on Monday-Thursday from 7:00am to 4:30pm., and on alternate Friday's from 7:00am to 3:30pm.

13. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Diego Gutierrez, can be reached at (571) 272-2245. The **only official fax phone number** for the organization where this application or proceeding is assigned is **(703) 872-9306**.



TAF
August 18, 2004



Diego Gutierrez
Supervisory Patent Examiner
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